DETAILED ACTION

Status of Claims

1. Claims 1-40 are pending and are examined below.

Comments

2. Applicant's amendments do not place the application in condition for allowance.

3. Applicants amendments and arguments have overcome the rejections under 35 U.S.C. 112, and therefore the 112 rejections have been withdrawn.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

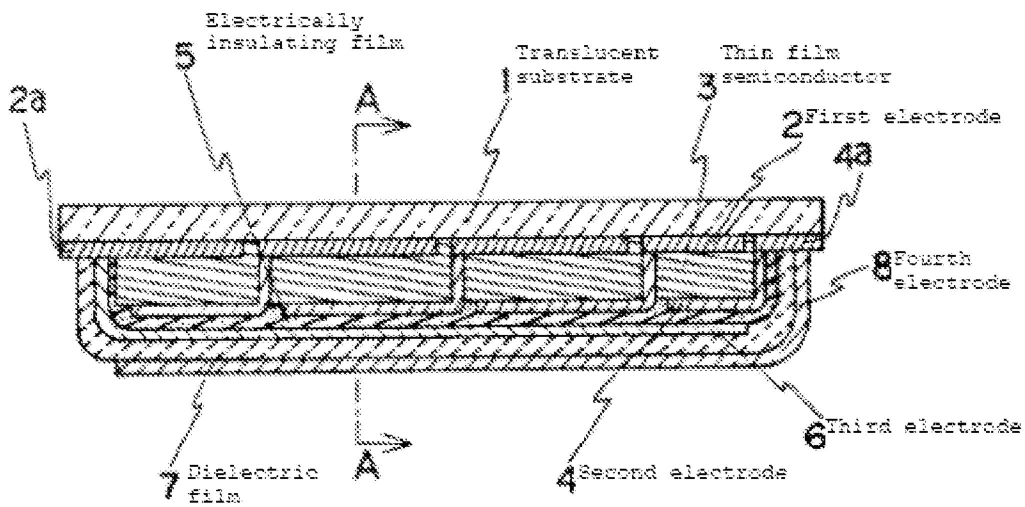
5. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

6. Claims 1-36 are rejected under 35 U.S.C. 103(a) as being unpatentable over Owada et al. JP No. 62/092380 in view of Delahoy et al., U.S. Patent No. 4,849,029 and Murphy et al. U.S. Patent No. 4,722,776.

Regarding Claim 1, Owada et al. teaches a photoelectrode comprising:

Figure 1



A transparent, insulating substrate (1);

A front contact layer (2) comprising a transparent conducting layer deposited on the substrate as a first electrode (see page 6);

At least one of a single junction semiconducting pn or pin layers, or multiple junction stacked pin or pn (3) layers that generate photovoltaic voltage under illumination (see page 8);

A back contact layer which is electrically conductive to form a back electrode B (6).

An insulating layer (5) that covers portions of the back contact layer;

A conducting layer that is electrically connected to the transparent conducting layer (4); It is inherent that an electrode can function either as an anode or a cathode.

Owada et al. does not teach the inclusion of a hydrogen evolution layer because Owada et al. does not specifically teach that the cells can be used for electrolysis. Owada et al. teaches TiO_2 as a dielectric layer (see page 12). TiO_2 is taught as a potential oxygen evolution reaction layer in the present application, so the oxygen evolution reaction layer as corresponding to the dielectric layer taught by Owada et al.

Delahoy teaches a photoarray suitable for electrolysis applications (see column 5, line 45 through column 6, line 8), which requires hydrogen and oxygen evolution, although Delahoy does not teach how these process are undertaken.

Murphy et al. teaches a photovoltaic cell design used for electrolysis comprising reaction layers comprising catalysts. These layers (200) are catalysts used by the present application, such as cobalt molybdate or ruthenium dioxide (see column 6, lines 45-55).

Therefore, it would be obvious to one of ordinary skill in the art to modify the photoelectrode taught by Owada et al. by including the oxygen and hydrogen evolution layers taught by Murphy et al. because the catalyst layers allow the cell to efficiently be used in an electrolysis process (see column 1, lines 25-35).

Regarding claim 2, Owada et al. teaches the layers separated into smaller area subcells, with each subcell containing both an anode and cathode (see fig. 1 and page 8).

Regarding Claim 3, Owada et al. teaches a photoelectrode as described above. Owada et al. does not specifically teach dividing the cell with scribe lines.

However, scribing, which produces scribe lines, is a method well known in the art for dividing photovoltaics and other semiconductor devices into subcells. For example, Delahoy teaches a photovoltaic device featuring arrays of photocells divided into subcells with laser scribing (see column 1, lines 25-45). Additionally, Delahoy teaches a photoarray suitable for electrolysis applications (see column 5, line 45 through column 6, line 8).

Therefore, it would be obvious to one or ordinary skill in the art to modify the photoelectrode taught by Owada et al. by incorporating the scribing process as taught by Delahoy because Delahoy teaches that scribing is effective in dividing the cell components in the creation of a device suitable for electrolysis applications (see column 1, lines 25-45).

Regarding Claim 4, Delahoy teaches separating the photoelectrode with laser scribe lines (see column 4, lines 20-35).

Regarding Claim 5, Delahoy teaches using scribe lines to: electrically isolate the front contact, remove portions of the thin film semiconductor layers, and remove portions of the back contact layer. These scribes correspond to the first, second, third, and fourth scribes claimed in claim 24. Furthermore, both Owada et al. and Delahoy teach forming a catalyst layer for electrolysis.

Regarding Claim 6, Owada et al. does not specifically teach individual subcells that not generate enough voltage for water electrolysis.

Delahoy teaches individual subcells that do not generate enough voltage for electrolysis (see fig. 1 and column 5, lines 20-25). Additionally, Delahoy teaches that

individual subcells can be connected using a scribe line to perform water electrolysis (see column 5, line 65 through column 6, line 7). Therefore, it would be obvious to modify the photoelectrode device taught by Owada et al. by selecting semiconducting materials that, although they do not generate enough voltage water electrolysis on their own, can generate enough voltage for water electrolysis when interconnected because of the necessity of low voltage/high current cells in photoelectrolysis applications (see column 2, lines 1-7).

Regarding Claim 7, Owada et al. teaches single and double junction solar cells (see pages 6 and 7).

Regarding Claim 8, Owada et al. teaches single junction thin film silicon solar cells (see fig. 1 and page 7).

Regarding Claim 9, Owada et al. teaches solar cells made from amorphous silicon (see page 7).

Regarding Claim 10, Owada et al. teaches single junction Cadmium Telluride (CdTe) solar cells (see page 7).

Regarding Claim 11, Owada et al. teaches double junction amorphous silicon and cadmium telluride solar cells (see page 8).

Regarding Claim 12, Owada et al. teaches an insulating layer that covers predetermined portions of the back contact (see fig. 1), along with a conducting layer electrically connected to the first electrode (see fig. 1). Additionally, the Examiner interprets the multijunction solar cells taught by Owada et al (see page 8) as capable of

generating enough voltage for electrolysis because the Owada et al specification reads on Claim 13, which narrows claim 12 with respect to solar cell material.

Regarding Claim 13, Owada et al. teaches both triple junction solar cells and high voltage double junction solar cells (see page 8). The double junction solar cells are considered by the examiner to be high voltage.

Regarding Claim 14, Owada et al. teaches the photovoltaic cell comprising, among other things, amorphous silicon, and CdTe (see page 12).

Regarding Claim 15, Owada et al. teaches the anode or cathode adapted to extend beyond a surface of the photovoltaic cell and back contact (see fig. 1).

Regarding Claim 16, Owada et al. teaches the front electrode electrically connected to a separate conducting layer (see fig. 1).

Owada et al does not teach the connection via a segment between two scribes.

However, scribing is a method well known in the art for dividing photovoltaic and other semiconductor devices into subcells. For example, Delahoy teaches a photovoltaic device featuring arrays of photocells divided into subcells with laser scribing (see column 1, lines 25-45). Additionally, Delahoy teaches a photoarray suitable for electrolysis applications (see column 5, line 45 through column 6, line 8).

Therefore, it would be obvious to one or ordinary skill in the art to modify the photoelectrode taught by Owada et al. by incorporating the scribing process as taught by Delahoy because Delahoy teaches that scribing is effective in dividing the cell components in the creation of a device suitable for electrolysis applications (see column 1, lines 25-45).

Regarding Claim 17, Owada et al. teaches solar cells that generate sufficient voltage for electrolysis. The examiner reads Owada et al., which includes a further limitation including triple junction solar cells as claimed below, to read on the limitation of Claim 17.

Regarding Claim 18, Owada et al. teaches triple junction and high voltage double junction solar cells (see page 12).

Regarding Claim 19, Owada et al. teaches the photovoltaic cell comprising, among other things, amorphous silicon, and CdTe (see page 12).

Regarding Claim 20, Owada et al. teaches a method of making a photoelectrode comprising:

Selecting a substrate that is transparent and insulating (see fig. 1 and page 5. The example substances can be both transparent and insulating).

Forming a transparent conducting layer on the substrate as a front electrode (see fig. 1 and page 5).

Forming at least one of single-junction semiconductor pn or pin layers or multiple junction stacked pn or pin layers that generate photovoltage under illumination (see page 6).

Forming an electrically conductive back contact layer to form a back contact;

Forming an insulating layer that covers portions of the back contact

Forming a conducting layer that is electrically connected to the transparent conducting layer.

Owada et al. does not teach the inclusion of a hydrogen evolution layer. Owada et al. teaches TiO_2 as a dielectric layer (see page 12). TiO_2 is taught as a potential oxygen evolution reaction layer in the present application, so the oxygen evolution reaction layer as corresponding to the dielectric layer taught by Owada et al.

Delahoy teaches a photoarray suitable for electrolysis applications (see column 5, line 45 through column 6, line 8), which requires hydrogen and oxygen evolution, although Delahoy does not teach how these process are undertaken.

Murphy et al. teaches forming a photovoltaic cell design used for electrolysis comprising forming reaction layers comprising catalysts. These layers (200) are catalysts used by the present application, such as cobalt molybdate or ruthenium dioxide (see column 6, lines 45-55).

Therefore, it would be obvious to one of ordinary skill in the art to modify the photoelectrode taught by Owada et al. by including the oxygen and hydrogen evolution layers taught by Murphy et al. because the catalyst layers allow the cell to efficiently be used in an electrolysis process (see column 1, lines 25-35).

Regarding Claim 21, Owada et al teaches the different layers separated into smaller area subcells (see fig. 1).

Regarding Claim 22, Owada et al. teaches a photoelectrode as described above. Owada et al. does not specifically teach dividing the cell with scribe lines.

However, scribing, which produces scribe lines, is a method well known in the art for dividing photovoltaics and other semiconductor devices into subcells. For example, Delahoy teaches a photovoltaic device featuring arrays of photocells divided into

subcells with laser scribing (see column 1, lines 25-45). Additionally, Delahoy teaches a photoarray suitable for electrolysis applications (see column 5, line 45 through column 6, line 8).

Therefore, it would be obvious to one or ordinary skill in the art to modify the photoelectrode taught by Owada et al. by incorporating the scribing process as taught by Delahoy because Delahoy teaches that scribing is effective in dividing the cell components in the creation of a device suitable for electrolysis applications (see column 1, lines 25-45).

Regarding Claim 23, Delahoy teaches separating the photoelectrode with laser scribing (see column 4, lines 20-35).

Regarding Claim 24, Delahoy teaches using scribing to: electrically isolate the front contact, remove portions of the thin film semiconductor layers, and remove portions of the back contact layer. These scribes correspond to the first, second, third, and fourth scribes claimed in claim 24. Furthermore, both Owada et al. and Delahoy teach forming a catalyst layer for electrolysis.

Regarding Claim 25, Owada et al. teaches the insulating layer covering predetermined areas of the back contact to protect surfaces from corrosion. Additionally, Owada teaches single junction solar cells which the Examiner reads as not generating enough voltage for electrolysis under illumination (see page 6).

Owada et al. does not specifically teach the fourth scribing.

Delahoy teaches a scribing applied to connect subcells, where the subcells generate sufficient voltage to drive water electrolysis (see column 5, line 45 through column 6, line 8).

Therefore, it would be obvious to one of ordinary skill in the art to modify the cell as taught by Owada et al. to apply the specific scribing as taught by Delahoy to connect two subcells together to have sufficient voltage to drive water electrolysis because scribing is a well known, cheap and available method of connecting unit cells in a photocell for water electrolysis.

Regarding Claim 26, Owada et al teaches single junction solar cells (see pages 6 and 7).

Regarding Claim 27, Owada et al teaches the use of single junction silicon based cells (see page 7).

Regarding Claim 28, Owada et al. teaches single junction cells of amorphous silicon (see page 7).

Regarding Claim 29, Owada et al. teaches single junction cells of Cadmium Telluride and amorphous silicon, among other things (see page 7).

Regarding Claim 30, Owada et al. teaches double junction amorphous silicon or cadmium telluride solar cells (see page 8).

Regarding Claim 31, Owada et al. teaches the insulating layer covering predetermined areas of the back contact to protect surfaces from corrosion. Additionally, Owada teaches multiple-junction solar cells which the Examiner reads as generating enough voltage for electrolysis under illumination.

Regarding Claim 32, Owada et al. teaches triple junction solar cells (see page 8).

Regarding Claim 33-36, Owada et al. teaches a double, triple, or quadruple junction cell featuring, among other materials, CdTe and amorphous silicon (see page 8).

7. Claims 37-40 are rejected under 35 U.S.C. 103(a) as being unpatentable over Reichman et al., U.S. Patent No. 4,646,103 in view of Delahoy et al.

Regarding Claim 37, Nagata et al. teaches

A photoelectrode (see column 2, lines 60-68);

An electrolyte, either acidic or alkaline in contact with an anode and cathode (see column 1, lines 45-55). Furthermore, although example 2 specifies water as an electrolyte, plain water can inherently be acidic or alkaline;

Compartments for an oxidation reaction (anode or cathode chamber depending on the pH of the electrolyte, see fig. 1 and column 1, lines 30-50);

Compartments for a reduction reaction (cathode or anode chamber depending on the pH of the electrolyte, see fig. 1 and column 1, lines 30-50);

An ion conduction layer (membrane 18);

An enclosure that confines the electrolyte for electrolysis (see fig. 1);

Reichman et al. does not teach a photoanode or cathode comprising a plurality of strip cells separated by an interconnection.

Delahoy et al. teaches a plurality of strip cells that are electrically connected via a scribe and form a photocathode in a photovoltaic electrolysis device. Delahoy et al. further teaches disposing the device in an acidic electrolyte.

Therefore, it would be obvious to one of ordinary skill in the art to modify the photoelectrodes taught by Reichman et al. by using the segmented devices taught by Delahoy et al. because the Delahoy et al. design can a device suitable for electrolysis applications (see column 1, lines 25-45).

Regarding Claim 38, Delahoy and Reichman et al. teaches producing hydrogen using solar radiation (see, e.g. Reichman at column 2, lines 1-15).

Regarding Claim 39, Delahoy et al teaches that solar radiation is directly applied to the plurality of strip cells (see fig. 2).

Regarding Claim 40, Delahoy et al. and Reichman et al. both teach that the substrate or front contact is incident to solar radiation (see Reichman et al. at fig. 1 and Delahoy et al. at fig. 2).

Response to Arguments

Applicant's arguments with respect to claims 1-40 have been considered but are moot in view of the new ground(s) of rejection.

Additionally, applicant argues that Owada et al. and Delahoy et al. are not analogous, because Owada et al. is directed at a charging device and Delahoy et al. is directed towards an electrode for an electrolysis process. This argument is not persuasive.

Both Owada et al. and Delahoy et al. teach photovoltaic devices that may be considered photoelectrodes. Furthermore, Delahoy et al. clearly teaches that such a device may be used with an electrolysis process. The required elements of the claims

as written are merely directed towards photovoltaic components, and, as photovoltaic devices Owada et al. and Delahoy et al. are analogous.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MATTHEW T. MARTIN whose telephone number is (571)270-7871. The examiner can normally be reached on 8:30 to 5:00 EST Monday through Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jennifer Michener can be reached on (571)272-1424. The fax phone

number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/MATTHEW T MARTIN/
Examiner, Art Unit 1795
11 January 2009

/Jennifer K. Michener/

Supervisory Patent Examiner, Art Unit 1795